

## **Green Phosphor and Plasma Display Panel using the same**

### **Technical Field**

This invention relates to a plasma display panel, and more  
5 particularly to a green phosphor that is adaptive for improving  
its driving voltage and brightness characteristic, and at the  
same time, improving its color purity.

### **Background Art**

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A plasma display panel has been the center of attention  
as the next generation display device which has the highest  
practicality among flat panel displays. That is, the plasma  
display panel has high brightness and wide viewing angle so that  
15 it can be applicable widely as a thin type of large-sized display  
such as an outdoor advertising tower, a wall TV or a theater  
display.

Generally, a plasma display panel displays a picture by  
20 use of a visible ray emitted by irradiating a phosphor with the  
ultraviolet generated by the discharge of the inert gas sealed  
inside a discharge cell.

FIG. 1 is a diagram representing the structure of a typical three electrode surface discharge type plasma display panel.

5 Referring to FIG. 1, a typical plasma display panel includes a scan electrode 2Y and a common electrode 2Z on an upper substrate 1; and a data electrode 6X formed on a lower substrate 5. At this moment, the scan electrode 2Y and the common electrode 2Z are formed in a direction to cross the data electrode 6X. And,  
10 the scan electrode 2Y and the common electrode 2Z constitute a pair of electrodes, and a plurality of such electrode pairs are arranged on the panel.

Also, an upper dielectric layer 3 and a protective film  
15 4 are sequentially deposited on the upper substrate 1, and a lower dielectric layer 7 and barrier ribs 8 are formed on the lower substrate 5. And, Phosphor is spread over the surface of the lower dielectric layer 7 and the barrier ribs 8 to form a phosphor layer 9. A discharge cell is formed at an area where  
20 the scan electrode 2Y and the common electrode 2Z cross the data electrode 6X.

Herein, the phosphor might include a red phosphor, a green phosphor and a blue phosphor. Each phosphor is spread along

the inner wall of each barrier rib 8. For example, the red phosphor might be (Y, Gd)BO<sub>3</sub>:Eu phosphor, the green phosphor might be Zn<sub>2</sub>SiO<sub>4</sub>:Mn (hereinafter referred to as ZSM) phosphor, and the blue phosphor might be BaMgAl<sub>10</sub>O<sub>17</sub>:Eu.

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However, the ZSM phosphor used as the green phosphor has a lower dielectric constant than the red phosphor and the blue phosphor and has negative surface potential. Accordingly, the ZSM phosphor has higher discharge voltage upon driving to act  
10 as a cause for reducing its voltage margin and as a cause for resulting in miswriting or the deviation of inversion characteristic.

(Y, Gd)BO<sub>3</sub>:Tb (hereinafter referred to as YBT) phosphor  
15 and BaAl<sub>12</sub>O<sub>19</sub>:Mn (hereinafter, referred to as BAM-G) phosphor might be used as the green phosphor other than the ZSM phosphor. However, the YBT phosphor has a characteristic that its purity is inferior to P22 for cathode ray tube CRT and the range of color reproduction become narrow, thereby deteriorating the  
20 picture quality. At the same time, BAM-G phosphor has a problem that its deterioration gets bigger upon driving.

## Disclosure

## Technical Problem

Accordingly, it is an object of the present invention to provide a green phosphor that is adaptive for improving its driving voltage and brightness characteristic, and at the same time, improving its color purity.

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It is another object of the present invention to provide a plasma display panel using the green phosphor.

#### Technical Solution

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In order to achieve these and other objects of the invention, a green phosphor according to one aspect of the present invention is composed of  $\text{Zn}_2\text{SiO}_4\text{:Mn}$  phosphor,  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$  phosphor and  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$  phosphor, and the mixing rate of  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$  phosphor to the total weight is 1~25 wt%.

A green phosphor according to another aspect of the present invention is composed of  $\text{Zn}_2\text{SiO}_4\text{:Mn}$  phosphor,  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$  phosphor and  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$  phosphor, and the mixing rate of the  
20  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$  phosphor to the  $\text{Zn}_2\text{SiO}_4\text{:Mn}$  phosphor is 25~80 wt%.

Herein, the mixing rate of the  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$  phosphor to the total weight of the green phosphor is 1~25 wt%.

A plasma display panel according to still another aspect of the present invention includes a plurality of electrodes arranged with having a first and a second sustain electrode form a pair on an upper substrate; a plurality of data electrodes  
5 arranged on a lower substrate to cross the electrodes; a plurality of barrier ribs arranged in parallel to the data electrodes with a designated gap to form a discharge space between the upper substrate and the lower substrate; and a plurality of phosphorus layers having a red phosphorus layer, a green phosphorus layer  
10 and a blue phosphorus layer which are formed along the inner wall of the barrier ribs, and wherein the green phosphorus layer is made of  $\text{Zn}_2\text{SiO}_4\text{:Mn}$  phosphor,  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$  phosphor and  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$  phosphor, and the mixing rate of  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$  phosphor to the total weight is 1~25 wt%.

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A plasma display panel according to still another aspect of the present invention includes a plurality of electrodes arranged with having a first and a second sustain electrode form a pair on an upper substrate; a plurality of data electrodes  
20 arranged on a lower substrate to cross the electrodes; a plurality of barrier ribs arranged in parallel to the data electrodes with a designated gap to form a discharge space between the upper substrate and the lower substrate; and a plurality of phosphorus layers having a red phosphorus layer, a green phosphorus layer

and a blue phosphorus layer which are formed along the inner wall of the barrier ribs, and wherein the green phosphorus layer is made of  $\text{Zn}_2\text{SiO}_4\text{:Mn}$  phosphor,  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$  phosphor and  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$  phosphor, and the mixing rate of the  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$  phosphor to the  $\text{Zn}_2\text{SiO}_4\text{:Mn}$  phosphor is 25~80 wt%.

Herein, the mixing rate of the  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$  phosphor to the total weight of the green phosphorus layer is 1~25 wt%.

10 A green phosphor according to still another aspect of the present invention includes a mixed phosphor composed of a first class phosphor of  $\text{Zn}_2\text{SiO}_4\text{:Mn}$ , a second class phosphor of at least one of  $\text{LaPO}_4\text{:Tb}$ ,  $\text{Y}_3\text{Al}_3(\text{BO}_3)_4\text{Tb}$ ,  $\text{Y}(\text{Al}, \text{Ga})_5\text{O}_{12}\text{:Tb}$ ,  $\text{YBO}_3\text{:Tb}$ ,  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$ , and a third class phosphor of at least one of  
15  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$ ,  $\text{BaAl}_{14}\text{O}_{23}\text{:Mn}$ ,  $\text{Ba}(\text{Sr}, \text{Ma})\text{AlO:Mn}$ , and the mixing rate of the third class phosphor to the total weight of the mixed phosphor is 1~25 wt%.

A green phosphor according to still another aspect of the  
20 present invention includes a mixed phosphor composed of a first class phosphor of  $\text{Zn}_2\text{SiO}_4\text{:Mn}$ , a second class phosphor of at least one of  $\text{LaPO}_4\text{:Tb}$ ,  $\text{Y}_3\text{Al}_3(\text{BO}_3)_4\text{Tb}$ ,  $\text{Y}(\text{Al}, \text{Ga})_5\text{O}_{12}\text{:Tb}$ ,  $\text{YBO}_3\text{:Tb}$ ,  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$ , and a third class phosphor of at least one of  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$ ,  $\text{BaAl}_{14}\text{O}_{23}\text{:Mn}$ ,  $\text{Ba}(\text{Sr}, \text{Ma})\text{AlO:Mn}$ , and the mixing

rate of the second class phosphor to the first class phosphor is 25~80 wt%.

Herein, the mixing rate of the third class phosphor to the  
5 total weight of the mixed phosphor is 1~25 wt%.

A green phosphor according to still another aspect of the present invention has a BAM group phosphor of at least one of  $\text{BaAl}_{12}\text{O}_{19}:\text{Mn}$ ,  $\text{BaAl}_{14}\text{O}_{23}:\text{Mn}$ ,  $\text{Ba}(\text{Sr},\text{Ma})\text{AlO}:\text{Mn}$  mixed with at least  
10 one type of phosphor that has a different composition from the BAM group phosphor, and the mixing rate of the BAM group phosphor to the total weight is 1~25 wt%.

A green phosphor according to still another aspect of the present invention includes a mixed phosphor in which a first  
15 class phosphor of  $\text{Zn}_2\text{SiO}_4:\text{Mn}$  is mixed with a second class phosphor of at least one of  $\text{LaPO}_4:\text{Tb}$ ,  $\text{Y}_3\text{Al}_3(\text{BO}_3)_4\text{Tb}$ ,  $\text{Y}(\text{Al}, \text{Ga})_5\text{O}_{12}:\text{Tb}$ ,  $\text{YBO}_3:\text{Tb}$ ,  $(\text{Y}, \text{Gd})\text{BO}_3:\text{Tb}$ , and the mixing rate of the second phosphor to the first class phosphor is 25~80 wt%.

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Herein, the mixed phosphor further includes a third class phosphor of at least one of  $\text{BaAl}_{12}\text{O}_{19}:\text{Mn}$ ,  $\text{BaAl}_{14}\text{O}_{23}:\text{Mn}$ ,  $\text{Ba}(\text{Sr},\text{Ma})\text{AlO}:\text{Mn}$ .

A plasma display panel according to still another aspect of the present invention includes a plurality of electrodes arranged with having a first and a second sustain electrode form a pair on an upper substrate; a plurality of data electrodes  
5 arranged on a lower substrate to cross the electrodes; a plurality of barrier ribs arranged in parallel to the data electrodes with a designated gap to form a discharge space between the upper substrate and the lower substrate; and a plurality of phosphorus layers having a red phosphorus layer, a green phosphorus layer  
10 and a blue phosphorus layer which are formed along the inner wall of the barrier ribs, and wherein the green phosphorus layer is composed of a first class phosphor of  $\text{Zn}_2\text{SiO}_4:\text{Mn}$ , a second class phosphor of at least one of  $\text{LaPO}_4:\text{Tb}$ ,  $\text{Y}_3\text{Al}_3(\text{BO}_3)_4\text{Tb}$ ,  $\text{Y}(\text{Al}, \text{Ga})_5\text{O}_{12}:\text{Tb}$ ,  $\text{YBO}_3:\text{Tb}$ ,  $(\text{Y}, \text{Gd})\text{BO}_3:\text{Tb}$ , and a third class phosphor  
15 of at least one of  $\text{BaAl}_{12}\text{O}_{19}:\text{Mn}$ ,  $\text{BaAl}_{14}\text{O}_{23}:\text{Mn}$ ,  $\text{Ba}(\text{Sr}, \text{Ma})\text{AlO}:\text{Mn}$ , and the mixing rate of the third class phosphor to the total weight is 1~25 wt%.

A plasma display panel according to still another aspect  
20 of the present invention includes a plurality of electrodes arranged with having a first and a second sustain electrode form a pair on an upper substrate; a plurality of data electrodes arranged on a lower substrate to cross the electrodes; a plurality of barrier ribs arranged in parallel to the data electrodes with



a designated gap to form a discharge space between the upper substrate and the lower substrate; and a plurality of phosphorus layers having a red phosphorus layer, a green phosphorus layer and a blue phosphorus layer which are formed along the inner wall of the barrier ribs, and wherein the green phosphorus layer is composed of a first class phosphor of  $\text{Zn}_2\text{SiO}_4\text{:Mn}$ , a second class phosphor of at least one of  $\text{LaPO}_4\text{:Tb}$ ,  $\text{Y}_3\text{Al}_3(\text{BO}_3)_4\text{Tb}$ ,  $\text{Y}(\text{Al}, \text{Ga})_5\text{O}_{12}\text{:Tb}$ ,  $\text{YBO}_3\text{:Tb}$ ,  $(\text{Y}, \text{Gd})\text{BO}_3\text{:Tb}$ , and a third class phosphor of at least one of  $\text{BaAl}_{12}\text{O}_{19}\text{:Mn}$ ,  $\text{BaAl}_{14}\text{O}_{23}\text{:Mn}$ ,  $\text{Ba}(\text{Sr}, \text{Ma})\text{AlO:Mn}$ , and the mixing rate of the second class phosphor to the first class phosphor is 25~80 wt%.

Herein, the mixing rate of the third class phosphor to the total weight of the green phosphorus layer is 1~25 wt%.

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#### **Advantageous Effect**

As described above, the plasma display panel of the present invention forms the green phosphor by mixing the ZSM phosphor, the YBT phosphor and the BAM-G phosphor, wherein the mixing rate of BAM-G phosphor is 1~25% to the total weight, thus the driving voltage and brightness characteristic might be improved and at the same time the color purity might be improved.

### Description of Drawing

FIG. 1 is a diagram representing the structure of a three electrode surface discharge type plasma display panel.

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### Best Mode for the Invention

These and other objectives and advantages of the present invention will be apparent from the description, by way of  
10 embodiments of the present invention, with reference to the appended drawings.

The preferred embodiments of the present invention will now be described in detail.

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The present invention, in order to solve the problem of ZSM, a green phosphor, which is generally used, realizes the green phosphor by mixing a first class phosphor, a second class phosphor and a third class phosphor, and determines the optimal  
20 mixing rate of the mixed phosphor on the basis of the result of experiment. Herein, the first class phosphor is  $\text{Zn}_2\text{SiO}_4:\text{Mn}$ , the second class phosphor is at least one of  $\text{LaPO}_4:\text{Tb}$ ,  $\text{Y}_3\text{Al}_3(\text{BO}_3)_4\text{Tb}$ ,  $\text{Y}(\text{Al}, \text{Ga})_5\text{O}_{12}:\text{Tb}$ ,  $\text{YBO}_3:\text{Tb}$ ,  $(\text{Y}, \text{Gd})\text{BO}_3:\text{Tb}$ , and the third class phosphor is at least one of  $\text{BaAl}_{12}\text{O}_{19}:\text{Mn}$ ,  $\text{BaAl}_{14}\text{O}_{23}:\text{mn}$ ,

Ba(Sr,Ma)AlO:Mn.

In relation to two component compound of the ZSM phosphor selected as the first class phosphor and the YBT phosphor selected as the second class phosphor, the result of the experiment carried out regarding optical characteristic, aging rate and electrical characteristic is shown as the following table 1.

TABLE 1

			ZSM (Base)	ZSM:YBT (0.75:0.25)	ZSM:YBT (0.5:0.5)
Optical Characteristic	Color Coordinate	X	0.233	0.249	0.257
		Y	0.726	0.705	0.693
	Initial Brightness(%)		100	107	98-100
Aging Rate	72 (hr)		-15	-6	-1
Electrical Characteristic	Discharge initiating voltage (V)		236	231	222

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As shown in Table 1, in case that the mixing rate of the YBT phosphor is increased, it is known that the initial brightness characteristic becomes excellent and the decreasing range of the aging rate is reduced. Further, as the mixing rate of the YBT phosphor increases, the discharge initiating voltage is reduced to make the electrical characteristic excellent.

Next, in relation to two component compound of the ZSM phosphor selected as the first class phosphor and the BAM-G phosphor selected as the third class phosphor, the result of the experiment carried out regarding optical characteristic, aging rate and electrical characteristic is shown as the following table 2.

TABLE 2

			ZSM (Base)	ZSM:BAM-G (0.75:0.25)	ZSM:BAM-G (0.5:0.5)
Optical Characteristic	Color Coordinate	X	0.242	0.226	0.206
		Y	0.717	0.725	0.736
	Initial Brightness (%)		100	103	107
Aging Rate	72 (hr)		-20.1	-27.1	-26.3
Electrical Characteristic	Discharge initiating voltage (V)		240	232	207

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As shown in Table 2, as the mixing rate of the BAM-G phosphor increases, the optical characteristic becomes excellent to make the color reproduction property get better accordingly. Further, as the mixing rate of the BAM-G increases, the initial brightness characteristic is known to increase from 100% to

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103~107% only when it is base phosphor (ZSM phosphor).  
Accordingly, as the mixing rate of the BAM-G phosphor increases,  
the initial brightness characteristic becomes excellent.  
However, when only ZAM phosphor constitutes the base phosphor,  
5 the aging rate decreases from -20.3% to -27.1% or -26.3% as the  
mixing rate of the BAM-G increases. Also, the discharge  
initiating voltage, when it is only the base phosphor (base  
phosphor), decreases at 240V linearly to have excellent  
electrical characteristic as the mixing rate of the BAM-G  
10 increases.

After all, the two component compound of the ZAM phosphor  
and the BAM-G phosphor has excellent color purity and initial  
brightness characteristic, and has a good discharge voltage  
15 decreasing effect. However, the aging characteristic is very  
much inferior to the base phosphor, which is formed only with  
the ZSM phosphor, thus it is possible to cause its life span  
shortening problem.

20 On the other hand, when mixing the YBT phosphor with the  
BAM-G phosphor, the result of the experiment carried out  
regarding optical characteristic, aging rate and electrical  
characteristic is shown as the following table 3.

TABLE 3

			ZSM (Base)	YBT:BAM-G (0.75:0.25)	YBT:BAM-G (0.5:0.5)
Optical Characteristic	Color Coordinate	X	0.243	0.268	0.205
		Y	0.715	0.649	0.699
	Initial Brightness (%)		100	93~98	85~100
Aging Rate	72 (hr)		-13.4	-16.5	-22.5
Electrical Characteristic	Discharge initiating voltage (V)		240	203	199

As shown in Table 3, as the mixing rate of the BAM-G phosphor increases, its color reproduction property increases but is inferior to the ZSM phosphor. Further, its initial brightness value is lower than that of the YBT phosphor, and its aging brightness decreasing rate is lower than the base phosphor which is composed only of the ZSM phosphor. In addition, its electrical characteristic becomes excellent in comparison with the base phosphor.

After all, the optical characteristic of the two component compound of the YBT phosphor and the BAM-G phosphor is not much improved and its color purity characteristic becomes very much deteriorated due to the reciprocal counter-action of each

component when compared with the base phosphor which is composed only of the ZSM phosphor. Also, it has an excellent discharge voltage decreasing effect, but the voltage decreasing effect becomes immaterial when the mixing rate of the BAM-G phosphor is not less than 25%. Accordingly, the two component compound of the YBT phosphor and the BAM-G phosphor does not have other advantage than the fact that the discharge initiating voltage decreases, in comparison with the base phosphor which is composed only of the ZSM phosphor, therefore it is unlikely to be applied for the plasma display panel.

As shown the above, in the result of experiment carried out in relation to the two component composition of mixing two phosphors among the ZSM phosphor, the YBT phosphor and the BAM-G phosphor, it is known that the optical characteristic and the aging rate and the electrical characteristic become excellent when the two component compound is composed of the ZSM phosphor and the YBT phosphor and the mixing rate of the YBT is 50 wt%.

Therefore, the present invention properly adjusts the mixing rate of the first class phosphor and the second class phosphor, and then changes the mixing rate of the third class phosphor to get the optimal composition rate of the mixed phosphor.

In relation to a three component compound of the first class phosphor, the second class phosphor and the third class phosphor, the result of the experiment carried out regarding optical characteristic, aging rate and electrical characteristic is shown as the following table 4.

TABLE 4

			ZSM (Base)	ZSM:YBT (0.5:0.5)	ZSM:YBT: BAM-G (0.44:0.44:0.12)	ZSM:YBT: BAM-G (0.38:0.38:0.25)
Optical Charact eristic	Color Coordi- nate	X	0.233	0.257	0.250	0.227
		Y	0.726	0.693	0.694	0.717
	Initial Brightness (%)		100	98-100	104	100
Aging Rate	72 (hr)		-15	-1	-2	-10
Electri cal Charact eristic	Discharge initiating voltage (V)		236	222	218	221

As shown in Table 4, when compared with the two component compound of the ZSM phosphor (the first class phosphor) and the YBT phosphor (the second class phosphor) with the same mixing



rate, in the three component compound of the ZSM phosphor (the first class phosphor), the YBT phosphor (the second class phosphor) and the BAM-G phosphor (the third class phosphor), the color purity becomes excellent as the mixing rate of the BAM-G, which is selected as the third class phosphor, increases. Also, the initial brightness characteristic becomes excellent from 98~100% in case of the two component compound of the ZSM phosphor and the YBT phosphor with the same mixing rate, to 100% in case of the three component compound of the ZSM phosphor, the YBT phosphor and the BAM-G phosphor.

The aging rate is -1% in case of the two component compound of the ZSM phosphor and the YBT phosphor with the same mixing rate, and it is -2% when the composition rate of BAM-G is 0.12 in case the three component compound of the ZSM phosphor, the YBT phosphor and the BAM-G phosphor. So, there is not much different in the aging characteristic. Of course, it is -10% when the composition rate of the BAM-G is 0.25, so it is not better than its being -1% in case of the two component compound of the ZSM phosphor and the YBT phosphor. But, it is better than the base phosphor (ZSM phosphor).

The discharge initiating voltage decreases linearly as the mixing rate of the BAM-G decreases.

Accordingly, in the three component compound of the ZSM phosphor, the YBT phosphor and the BAM-G phosphor, the mixing rate of the BAM-G phosphor to the total composition is set to be within the scope of 1~25 wt%. Further, the mixing rate of the YBT phosphor to the ZSM phosphor is set to be within the scope of 25~80 wt%.

Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.